THE SOARING OF BIRDS.[1]

SO much for sails. Now I want to make some suggestions, or suggest some queries, as to the *skimming* flight of birds, in reference to which a good deal of fresh observation has been possible during the voyage.

You perhaps recollect that when the British Association was at Glasgow, you asked me to put into writing, briefly, as a paper for your Section, some remarks on this subject which I had made to you in conversation, but that, owing to my hasty departure to attend the trial of H.M.S. *Shah*, I omitted to do this.

I had better briefly recite the above particulars here in order to make more clear the bearing of the new observations we (I and Tower) have made.

The view was that when a bird skims or soars on quiescent wings, without descending and without loss of speed, the action must depend on the circumstance that the bird had fallen in with, or selected a region where the air was ascending with a sufficient speed. In still air the bird, if at a sufficient height, could continue to travel with a steady speed, using his extended wings as a sort of descending inclined plane, the propelling force depending on the angle of the plane and on the equivalent of "slip,"—that is to say, on the excess of the angle of actual descent compared with the angle of the inclined plane. The steady speed would be attained when the weight of the bird and the sines of the angle of the plane = the bird's *air resistance*, including skin friction of wings—in fact one might say = simply the skin friction of the whole area, for the bird's lines are fine enough to justify this statement, since there is no wave-making to be done, and indeed experiment shows that the statement is true for "fish-formed" bodies moving wholly and deeply immersed in water. Of course the bird's angle of actual descent is greater than that of the quasi-inclined plane, owing to the equivalent of "slip" in the wings. Under these simultaneously acting and correlated conditions there is of course—or probably—some total angle of descent which enables the bird to minimize his rate of approach to the earth in still air. If when there is a wind the configuration of the ground or any other circumstances can produce a local ascent of air more rapid than the bird's minimum rate of descent when soaring in still air, he may continue to soar indefinitely by keeping in the region where the air is thus ascending.

Now, in most cases where one sees birds "soaring," it is easy to see that they have plainly selected such a region, and for a long time I felt confident that the only two even apparent exceptions I had encountered were such as to *prove* not to *invalidate* the rule. One of these exceptions was that once, when the sea in Torbay was in a state of glassy calm, I noticed a large gull thus soaring at some distance from the shore,—watching it with a pair of binoculars, so that I was sure of the quiescence of the wings. But here the riddle was at once solved by the observation of what I had not at first noticed—the dark trace of the front line of a fresh sea-breeze advancing all across the bay. Such an advance with a definitely marked front, encountering an extended body of quiescent air, involved of course an ascent of air in the region of the encounter, and this was where the bird was soaring. The other exception was that when at sea I had often noticed birds thus soaring near the ship. The solution was that, so far as I had then noticed, the birds always selected a region to leeward of the ship, where the eddies created by the rush of air past her hull, &c., might readily have created local ascending currents.

The new exceptions we have seen since we have approached the Cape entirely set these two solutions at defiance.

The first exception we noticed was in the flight of some albatrosses. We were sailing, and steaming (at low speed, being short of coal), nearly due east in the latitude of the Cape, with the wind light and variable abaft the beam, and with a well-marked south-west swell of about 8 to 9 seconds period, and varying from 3 or 4 feet to 8 or 9 feet from hollow to crest. The speed of such waves would be from 24 to 27 knots.

Under these conditions the birds *seemed* to soar almost *ad libitum* both in direction and in speed; now starting aloft with scarcely, if any, apparent loss of speed; now skimming along close to the water, with the tip of one or other wing almost touching the surface for long distances, indeed now and then actually touching it. The birds were so large that the action could be clearly noted by the naked eye even at considerable distances; but we also watched them telescopically, and assured ourselves of the correctness of our observations. The action was the more remarkable owing to the lightness of the wind, which sometimes barely moved our sails, as we travelled only 5 knots before it, by help of the screw.

After long consideration the only explanation of at all a rational kind which presented itself was the following, which indeed presents the action of a *vera causa*, and one which was very often certainly in accordance with the birds' visible movements, though it was often also impossible either to assert or to deny the accordance; and anyhow the question arises, Is the *vera causa* sufficient? I will try to trace its measure.

When a wave is say of 10 feet in height and say 10 seconds period (a case near enough to ours to form the basis of a quantitative illustration) the length of the wave from crest to crest is just 500 feet, the half of which space, or 250, the wave of course traverses in 5 seconds, and assuming the wave to be travelling in a calm, it must happen approximately that during the lapse of this 5 seconds the air which at the commencement of the interval lay in the lowest part of the trough has been lifted to the level of the crest, or must have risen 10 feet, so that its mean speed of ascent has been 2 feet per second (10 feet in 5 seconds). And since (as is well known) the maximum speed of an harmonic motion is $\frac{\pi}{2}$ times, or nearly $1\frac{1}{2}$ times its mean speed, it follows that along the side of the wave at its mid-height the air must approximately be ascending at the rate of 3 feet per second, and if the bird were so to steer its course and regulate its speed as to conserve this position he would have the advantage of a virtual upward air current having that speed.

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[1] Extract from a letter of the late William Froude to Sir W. Thomson, of February 5, 1878, received after Mr. Froude's death. Reprinted from the Proceedings of the Royal Society of Edinburgh, March 19, 1888.

NOTES.

THE Berlin Academy of Sciences has presented 2000 marks (£100) to Prof. Leopold Auerbach (Breslau), and the same amount to Dr. Franz Schütt (Kiel), to aid them in their physiological researches. Dr. Freudenthal, Professor of Philosophy at Breslau, and Herr von Rebaur-Paschwitz, the astronomer, have received 1500 marks (£75) each.

AT the last meeting of the Scientific Committee of the Royal Horticultural Society, Mr. Henslow called attention to the fact that the year 1889, besides being the centenary of the chrysanthemum in Europe, is that of the dahlia in England. It was introduced by the Marchioness of Bute in 1789, and figured with single and double forms in the *Botanical Magazine*, vol. xliv., t. 1885, and the *Botanical Register*, vol. i. t. 55.

THE death of Mr. J. J. Coleman, F.R.S.E., is announced. He died at the age of fifty. For some time he was manager of the works of Young's Paraffin and Mineral Oil Company, Glasgow; and in this capacity he carried out some important experimental investigations for the utilization of so-called waste products. Afterwards he invented the refrigerating machine which bears his name, a machine which has increased and cheapened the available supply of fresh meat.

ON Tuesday, the 8th inst., the second of the series of one-man photographic exhibitions at the Camera Club will be open to visitors on presentation of card. The Exhibition will continue for about six weeks. The object of this series of Exhibitions is to bring together in turn representative collections of the work of the best photographic artists. By the co-operation of Mr. Harry Tolley, of Nottingham, the Camera Club is enabled to exhibit a representative set of his photographs. These pictures are large direct work, and are printed in the permanent platinum process.

A COURSE of six lectures on "The Science of Brewing" will be given at the Finsbury Technical College by Dr. E. R. Moritz, commencing Wednesday, January 23, and being continued on successive Wednesday evenings. Other courses of special lectures will be given during the present term by Prof. Perry, on "The Differential Calculus and its Application to Problems of Electrical and Mechanical Engineering"; by Prof. S. P. Thompson, on "Optical Principles and Practice"; and a special laboratory course on "Electro-deposition" (plating and typing), by Mr. Rousseau.

ACCORDING to the *Standard* of December 29, 1888, Hampshire was visited, at 11 o'clock on the morning of the 28th, with what was believed to be an earthquake. There were, it is reported, a severe subterranean rumbling and a concussion in the neighbourhood of Emsworth Common. A horse and cart passing at the time were visibly shaken, and two men were nearly knocked off their legs. There was a violent rustling of the trees in the neighbourhood, and the shock appeared to extend over a wide area.

ON Sunday, December 23, a severe shock of earthquake was experienced in Calcutta and throughout Bengal. In Rajshahye large fissures opened, whence hot liquid mud was ejected. The Calcutta Correspondent of the *Times*, reporting these facts by telegraph on December 30, said no loss of life had been heard of.

SEVERAL severe shocks of earthquake were felt in Bosnia, on December 18, especially at Rogatica, Cajnica, Pleolje, and Poljancic.

THE University of Edinburgh continues to attract a very large number of students. During the past year, according to the Edinburgh Correspondent of the *Times*, the total number of matriculated students was 3532, as against 3459 last year, 2667 in 1878, and 1564 in 1868. Of this total, 1008 were enrolled in the Faculty of Arts, 108 in the Faculty of Divinity, 474 in the Faculty of Law, and 1942 in the Faculty of Medicine. Of the students of medicine 832 (or 43 per cent.) belonged to Scotland, 705 (or fully 36 per cent.) were from England and Wales, 36 from Ireland, 79 from India, 247 (or nearly 13 per cent.) from British colonies, and 43 from foreign countries.

AT the Bath meeting of the British Association, a Report was presented by the Committee which had been appointed to consider the advisability and possibility of establishing in other parts of the country observations upon the prevalence of earth tremors similar to those now being made in Durham. Considering that much is being done with the object of securing suitable forms of instruments, and that these investigations are still incomplete in many ways, the Committee felt that it would be premature for them to select and recommend any special recorder at present. They, however, emphasized the view that, whilst carefully finished, highly sensitive, and necessarily expensive seismoscopes, made to record with as much accuracy as possible the time, form, and intensity of each set of tremors, are very desirable, and indeed indispensable, yet only a comparatively small number of such instruments would be required in a general scheme of seismographical observatories. Such instruments, moreover, could only be used with effect in carefully selected situations, and otherwise under very special conditions. On the other hand, comparatively rough, cheap, and easily used instruments, which could do little more than afford fairly accurate time-records, would be required in large numbers, and must form a most important portion of such a scheme. The Committee hoped that at the next meeting of the Association they might be in a position to present a Report containing definite recommendations.

THE Chief Signal Officer of the United States reports that in the reorganization of the Record Division of the Signal Office he found a large amount of valuable rainfall data, furnished by voluntary observers prior to 1874. With a view of making these records available, he has published them in an atlas of rain charts of the United States, for each month of the years 1870-74; these will be found especially useful in the study of weather conditions over that country. He also states that an examination of the records of the voluntary observers shows that it will be possible to further utilize them in the preparation of normal temperature charts, which he hopes to be able to issue with the Monthly Weather Review at an early date. An eighteen-year normal monthly rain-chart is now being regularly issued in this Review.

IN December 1877, Prof. F. E. Nipher established a volunteer weather service in Missouri, the object being primarily to investigate the rainfall of that State, and he has now published the results in a paper entitled "Missouri Rainfall." It contains maps and tables showing the average monthly amounts for ten years ending 1887, at thirty-one stations, together with the maximum and minimum monthly and yearly falls. The yearly averages vary from 31·4 inches to 45·7 inches.

IN a recent lecture on Bacteria, delivered at Brooklyn, Dr. George M. Sternberg pointed out that the rapid progress of bacteriology in Germany has been due, to a very considerable extent, to the enlightened policy of the Government. Dr. Sternberg is of opinion that if, during the past ten years, the Americans had had a well-equipped laboratory, under proper direction, the medical corps of the army and navy could easily have supplied men who would have done good work in this department of research. He thinks it is not creditable to the United States as a nation that Americans have contributed so little to the advance of bacteriology. "Let us hope, however," he added, "that we are entering upon a new era. Here in Brooklyn private munificence has provided the means of research which the National Government should have provided long since; and here, at least, the fault will rest with the profession, if active workers are not found to avail themselves of the facilities provided for making original researches in bacteriology, in physiology, and in experimental pathology." The "private munificence" referred to is that of Dr. Hoagland, who has equipped a laboratory at Brooklyn. This laboratory, which has been organized in accordance with the best models, is to be devoted exclusively to scientific research, and to instruction in physiology, pathology, histology, and bacteriology.

THE tenth volume of the Proceedings of the United States National Museum has been issued. The series to which this volume belongs consists of papers prepared by the scientific corps of the National Museum; of papers by others, founded upon the collections in the National Museum; and of brief records of interesting facts from the correspondence of the Smithsonian Institution.

THE new number—the sixth—of the *Internationales Archiv für Ethnographie* completes the first volume of this excellent periodical. Among the plates is a coloured representation of the deerskin mantle, ornamented with-shell work, recorded to have belonged to the Virginian Chief, Powhattan. Dr. E. B. Tylor contributes, in English, an account of this interesting object, which forms one of the treasures of the Ashmolean. It belongs to the Tradescant collection, which was the nucleus of the museum of Elias Ashmole. It seems that there were in use among the Powhattans three kinds of mantles, viz. of dressed skins embroidered with beads (including shells), of furs, and of feather work. In the original collection of Tradescant there were specimens of all three kinds. Of these, the shell-embroidered mantle alone remains. It measures about 2·2 m. in length by 1·6 m. in width. The two deerskins forming it are joined down the middle; no hair remains. The ornamental design consists of an upright human figure in the middle, divided by the seam; a pair of animals; thirty-two spirally formed rounds (two in the lowest line have lost their shells); and the remains of some work in the right lower corner. Dr. Tylor says that the decorative shell-work is of a kind well known in America. The shells used are *Marginella*: so far as Mr. Edgar A. Smith is able to identify them in their present weathered state, *M. nivosa*. Among the other contents of the number are some notes, in German, on the ethnography of Mexico, by Carl Breker, and an attempt, by M. Messikommer, to describe some elements of what may have been the intellectual life of the inhabitants of ancient lake-dwellings.

IN the new number of the Transactions of the Leicester Literary and Philosophical Society, there is a useful and interesting paper, by Mr. Montagu Browne, Curator of the Town Museum, Leicester, on "Evidences of the Antiquity of Man in Leicestershire." He begins with objects of bone and horn, then examines the remains of pottery, and finally deals with articles in bronze and stone. Palæolithic implements have not yet been discovered in Leicestershire, but Mr. Evans, in a passage quoted by Mr. Browne, is of opinion that they may be found there. "It is by no means impossible," writes Mr. Evans, "that you may succeed in finding them. It is a little far north, but I doubt whether the glaciers persisted so long in that part of England as they did in the Lake District, and in Wales."

MESSRS. CASSELL AND CO. are issuing, in monthly parts, a popular edition of "The Story of the Heavens," by Sir Robert S. Ball, the Royal Astronomer of Ireland. The work, which is well printed on good paper, will be completed in eighteen parts. With Part I., which we have just received, a star map is given.

THE "Educational Annual" for 1889, compiled by Edward Johnson, has been issued. Messrs. G. Philip and Son are the publishers. The work is designed to place within reach of the general public a concise summary of authentic information, drawn from official or other trustworthy sources, relative to primary and secondary education, in a form convenient for reference. Information relating to training colleges for teachers and teachers' associations has been included.

A BOOK, entitled "Rides and Studies in the Canary Islands," by Mr. Charles Edwardes, has just been published (Fisher Unwin). The author quaintly explains that it is written "for the entertainment both of those who visit the Canary Islands and those who do not." A considerable part of the book has already appeared in the form of articles in magazines and journals. Those who have already read these fragments will not object to find them again among Mr Edwardes's lively and pleasant sketches.

WE have received a diary called "The Perennial Diary," which a good many people may find useful. It is not intended to supersede ordinary diaries. Each page is devoted to a single day of the year, and events occurring on that day in different years may all be entered on the same page. The volume is issued by Mr. John Heywood, of Manchester and London.

THE Free Libraries Committee of Manchester are able to give, in their thirty-sixth Annual Report, a most favourable account of all departments of the institutions under their charge. The number of the buildings in which the work of the Committee is carried on has been increased to ten by the establishment of the Hyde Road Reading Room, which was opened some time ago by the Mayor, in the presence of a large and enthusiastic meeting of the inhabitants of the district. In the course of the last twelve months the number of readers at the various libraries and reading-rooms (*i.e.* the number of visits they have made) reached an aggregate of nearly four millions and a half, or about a quarter of a million more than in the previous year. There has been an increase also in the number of books read. The number used for home reading and for perusal in the reading-rooms has been 1,606,874, against 1,462,028 volumes read in the preceding twelve months. The daily average of volumes used in all the Libraries was 4464.

IN the letter on "Nose-blackening as preventive of Snow-blindness," by Mr. A. J. Duffield (vol. xxxviii. p. 172), *for* "New Zealand" *read* "New Ireland."

THE additions to the Zoological Society's Gardens during the past week include a Common Kestrel (*Tinnunculus alaudarius*) captured at sea, presented by Mr. Thomas Austin; a Pyxis Tortoise (*Pyxis arachnoides*) from Durban, Natal, presented by Colonel J. H. Bowker, F.Z.S.; a Rat-tailed Snake (*Trigonocephalus lanceolatus*) from St. Lucia, W.I., presented by the West Indian (Natural History) Exploration Committee; two Concave-casqued Hornbills (*Buceros bicornis*) from India, deposited; a ——— Squirrel (*Sciurus* sp. inc.) from Burmah, two Ceylonese Hanging Parrakeets (*Loriculus asiaticus*) from Ceylon, purchased.

OUR ASTRONOMICAL COLUMN.

DETECTION OF NEW NEBULÆ BY PHOTOGRAPHY.—Prof. Pickering gives a brief account, in No. 6 of the Annals of Harvard College Observatory, vol. xviii., of some experiments he has recently conducted as to the advantages of a photographic doublet over an ordinary astronomical object-glass for astronomical work, and especially in photographing nebulæ. A number of plates were exposed upon the region of Orion, the instrument used being the Bache telescope, which has a photographic doublet with an aperture of 8 inches and a focal length of 44 inches: each plate covered a region 10° square, the definition being good within 3½° of the centre of the plate. The result of the experiments was the detection of twelve new nebulæ; fourteen nebulæ were seen on the photographs that were also given in Dreyer's Catalogue, and four nebulæ in the Catalogue were not represented on the plates. A similar proportion of discovery over the entire sky would mean some 4000 or 5000 new nebulæ, and 400 plates would be sufficient for a complete survey, provided here was no overlapping, and no plates proved defective.

COMETS FAYE AND BARNARD, OCTOBER 30.—The following ephemeris for Faye's comet is in continuation of that given in NATURE (vol. xxxix. p. 186). The ephemeris for Barnard's comet is by Herr Spitaler (*Astr. Nach.*, No. 2871). Both are for Berlin midnight:—

	Comet 1888 *d* (Faye).		Comet 1888 *f* (Barnard, Oct. 30).	
1888.	R.A.	Decl.	R.A.	Decl.
	h. m. s.	° ′	h. m. s.	° ′
Jan. 4	7 58 38	0 11·7 N.	10 25 49	4 42·3 N.
6	7 56 57	0 14·2	10 24 55	5 45·1
8	7 55 15	0 17·7	10 23 51	6 49·1
10	7 53 32	0 22·3	10 22 40	7 54·4
12	7 51 49	0 27·9	10 21 22	9 0·6
14	7 50 6	0 34·5	10 19 58	10 7·6
16	7 48 26	0 42·1 N.	10 18 24	11 15·2 N.

Both comets are slowly diminishing in brightness.